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TWELFTH UNITED NATIONS REGIONAL CARTOGRAPHIC
CONFERENCE FOR ASIA AND THE PACIFIC
Bangkok, 20-28 February 1991
Item 7 (e) of the provisional agenda*

CARTOGRAPHIC DATA RETRIEVAL, ANALYSIS, DEPICTION, PRESENTATION AND PRODUCT GENERATION: SPECIFICATIONS AND STANDARDS

Action on resolution 13: Exchange of digital cartographic data

Submitted by the United Nations Secretariat**

Resolution 13 adopted by the eleventh United Nations Regional Cartographic Conference for Asia and the Pacific called on the United Nations:

"(a) ... to recommend a standardized, universal data exchange format to facilitate the exchange of digital cartographic data;

(c) Initiation of a study of the technical means by which geo-related data bases can best be integrated on a national level."

This resolution was considered by the Working Group convened by the United Nations Natural Resources and Energy Division/Department of Technical Co-operation for Development in Vienna from 24 September to 2 October 1990. The Workshop on Training and Transfer of Technology in Digital Cartographic Data and Evaluation of Systems for Digital Mapping was attended by experts in the field selected by the United Nations from nominations made by ICA, FIG and ISPRS, the current constituent members of IUSM.

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* E/CONF.83/1.

** Prepared by the Workshop on Training and Transfer of Technology in Digital Cartographic Data and Evaluation of Systems for Digital Mapping (Vienna, 24 September-2 October 1990).

The Working Group was aided in its consideration of resolution 13 by a paper prepared by Dr. A. Brandenberger.

Since resolution 13 was adopted, considerable activity has taken place in the field of standards for digital cartographic data and it was the opinion of the Working Group that events had overtaken the original resolution. Several nations have produced documentation on standards and there are several proposals for data exchange under discussion at a national and international level. The commercial sector is also involved in the development of standards.

The Working Group decided that the interests of the member States participating in the twelfth United Nations Regional Cartographic Conference for Asia and the Pacific would best be served by providing information and documentation on the current state of work on standards. The International Cartographic Association has a Working Group which has collected extensive documentation on this topic. It was recommended that ICA be asked by UN/DTCD to provide a paper on the current situation on the exchange of digital cartographic data to be introduced by an ICA representative at the twelfth United Nations Regional Cartographic Conference for Asia and the Pacific in Bangkok, 1991.

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TWELFTH UNITED NATIONS REGIONAL
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Item 8 (a) of the provisional agenda*

MANAGEMENT OF NATIONAL MAPPING AND CHARTING PROGRAMMES: EDUCATION AND TRAINING

Action on resolution 20: Training in modern technology in the developing countries

Paper submitted by the United Nations Secretariat**

Resolution 20 of the eleventh United Nations Regional Cartographic Conference for Asia and the Pacific recommended the United Nations "to prepare an inventory of video-tapes for training at all levels in the various modern technologies of surveying, cartography, digital mapping satellite geodesy, reproduction and printing, and that this inventory should be updated regularly with advances in technology; ... the updated inventory should be made available to member nations on an annual basis."

This resolution was considered by a Working Group convened by the United Nations Natural Resources and Energy Division/Department of Technical Co-operation for Development in Vienna from 24 September to 2 October 1990. The "Workshop on Training and Transfer of Technology in Digital Cartographic Data and Evaluation of Systems for Digital Mapping" was attended by experts in the field selected by the United Nations from nominations made by International Cartographic Association (ICA), Fédération International de Geomètres (FIG) and International Society of

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* E/CONF.83/1.

** Prepared by the Workshop on Training and Transfer of Technology in Digital Cartographic Data and Evaluation of Systems for Digital Mapping (Vienna, 24 September-2 October 1990).

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Photogrammetry and Remote Sensing (ISPRS), the current constituent members of International Union of Surveys and Mapping (IUSM).

The Working Group reviewed the contents of resolution 20 which had originally stemmed from work that was being undertaken at the International Training Centre (ITC) in the Netherlands in 1987. Since the adoption of the resolution, a number of developments have taken place in the field of expert systems and computer assisted learning (CAL). Technological developments have been so wide-ranging and so rapid that any video system can only play a small part in the education and training process. Videos can help in the development of awareness and in drawing attention to issues that must be addressed; but they are insufficiently flexible to replace more conventional teaching methods. A variety of aids to education and training in GIS is now available, amongst which are CAL packages, and the work of the National Centre for Geographic Information Analysis (NCGIA). CAL packages include, amongst many others, the GIS Tutor (GIST) produced by Birkbeck College at the University of London, a similarly named package produced at the Asian Institute of Technology (AIT) Bangkok, Thailand, and packages produced at the University of Aalborg in Denmark. The NCGIA has produced a series of 72 lectures, including guidance notes, overhead transparency originals and 35 mm slides that cover the whole field of GIS technology and implementation. In addition, several vendors provide "tutors", which are CAL packages that help to explain the operation of specific products. These packages include manuals and examples for the student to work through. A number of GIS text-books and journals have also appeared since 1987 and many conferences have taken place. There is thus now very much more information available on GIS.

The Working Group emphasized the fundamental importance and necessity for education and training in spatial information management. They were concerned that problems exist in educating and training staff at all levels, from basic technician and operator skills for instance in digitizing (where aptitude tests are important and available to determine those who are suited or otherwise for training and have a potential to develop the necessary skills) through broader technician training to graduate and post-graduate courses.

They were concerned that insufficient attention was being addressed to the training of middle and senior managers since management skills are a prerequisite to the successful implementation of spatial information management systems. The Group recognized that a number of educational courses were available in North America, Europe and Australasia, but that there was a need for more customized courses for individual less developed countries. They were aware that other organizations within the United Nations are addressing problems of information technology transfer and training and that it was not their remit to address such issues other than in the context of video aids to GIS training. They wished to stress that whereas videos have a role to play, their inflexibility and the inevitable problems of updating their content made them only minor tools in solving a major problem - the development of skills and understanding in spatial information systems and management. They recommended that the Conference in Bangkok should urgently address the overall problem of training and education at all levels.

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Item 5 (b) of the provisional agenda*

CARTOGRAPHIC DATA ACQUISITION AND SUPPORTING ACTIVITIES: ACQUISITION OF CARTOGRAPHIC DATA FROM AIRBORNE AND SPACE PLATFORMS

Guide to standard technical specifications for aerial photography (revision)

Paper submitted by the United Nations Secretariat**

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* E/CONF.83/1.

** Prepared by the United States Geological Survey, Reston, Virginia, United States of America.

GUIDE TO STANDARD TECHNICAL SPECIFICATIONS FOR AERIAL PHOTOGRAPHY

PREFACE

The Economic and Social Council, in its resolution 131 (VI) of 19 February 1948, recommended that Member Governments stimulate accurate surveying and mapping of their national territories, and that the Secretary-General take appropriate action, within the limits of budgetary availabilities, to further such efforts by promoting the exchange of technical information and other means, including the preparation of a study on modern cartographic methods and development of uniform international standards.

In view of the increasing use of aerial photography in connection with United Nations Development Programme projects, the United Nations Department of International Economic and Social Affairs, as part of its efforts to develop uniform cartographic standards, has undertaken the preparation of Standard Technical Specifications for Aerial Photography.* The specifications have been prepared in such a way as to be particularly appropriate for use in geographic areas receiving United Nations Development Programme assistance and published in the United Nations publication "World Cartography", vol. X, 1970.

The Eleventh United Nations Cartographic Conference for Asia and the Pacific (Bangkok, 1987) and the Fourth United Nations Cartographic Conference for the Americas (New York, 1989), noting that new advances have been made in the technical progress of aerial photography, recommended that the United Nations Secretariat should undertake the updating and publication of the specifications in a revised form.

Implementing these recommendations, the United Nations Department of Technical Co-operation for Development (UNDTCD) has undertaken a revision of the specifications.

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* The Secretariat wishes to acknowledge the assistance it has received from the United States Geological Survey, Reston, Virginia.

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INTRODUCTION

These specifications cover technical requirements and standards of equipment, performance and recommended procedures applicable to the procurement of aerial photography that will be used for photogrammetric compilation of cadastral, topographic and special-purpose maps, and for natural resources evaluation and inventory.

The specifications are applicable to the procurement of panchromatic, infra-red, colour infra-red (false colour) and normal colour photography having proper metrical characteristics and quality for photogrammetric applications, including analytical aerotriangulation, stereotriangulation and map compilation with conventional photogrammetric compilation instruments and procedures.

I. OPERATIONAL REQUIREMENTS

A. Area to be photographed

The location, size and boundaries of the area to be photographed shall be as delineated in the schedule of specific requirements applicable to the project as issued by the procuring authority.

B. Flight lines

Unless indicated to the contrary in the schedule of specific requirements for the project, all photographic strips shall be flown north-south or east-west within 5 degrees of true cardinal direction. The mean bearing of adjacent strips shall be parallel within 5 degrees. Particular care shall be exercised to keep all flight lines as straight and as nearly parallel as possible. In no case shall the lack of parallelism between adjacent strips or sections thereof be such as to prevent the sidelap between photographs from conforming with the requirements for sidelap (see section I.C.2). Contiguous strips shall be flown in sequence, and each flight line shall be continuous across the project area. Breaks in strip continuity will be allowed only where necessitated by weather, conditions that could not be avoided by the exercise of reasonable diligence and care on the part of the flight crew, or when change in flight altitude is required to satisfy sidelap or photo scale requirements. When a break in strip continuity is necessary, the strip sections shall endlap by at least two photographs. Coverage beyond the boundaries of the project which are parallel to the flight lines shall be not less than 15 per cent of the width of the photograph. All of the area appearing on the first and the last negative in each flight line extending over a boundary shall be outside the boundary of the project area.

If necessary, the positioning of flight lines and photographs in relation to given terrain features will be indicated in the schedule of specific requirements.

C. Overlap

The overlap shall be sufficient to provide full stereoscopic coverage as follows:

1. Endlap

The endlap (overlap in line of flight) shall average approximately 60 per cent, and any overlap less than 55 per cent or more than 65 per cent shall be considered sufficient grounds for rejecting all photographs made on that flight line. In cases of extreme variation in elevation within an area, deviations from the above requirement may be permitted by the contracting authority provided it is proved that topographic features in the area warrant such deviations. Under such circumstances, deviations from specifications shall be limited to the area where the conditions prevail and, in any event, complete stereoscopic coverage will be required.

2. Sidelap

The sidelap (overlap of parallel strips of photography) shall average either 30 per cent or 60 per cent as specified in the schedule of specific requirements. When 30 per cent sidelap is specified, any sidelap less than 15 per cent or more than 45 per cent shall be considered sufficient grounds for rejecting all photographs on that flight line. When 60 per cent sidelap is specified, any sidelap less than 45 per cent or more than 75 per cent shall be considered sufficient grounds for rejecting all photographs on that flight line.

D. Flight height

The flight height above mean ground elevation shall be computed as follows:

$$H = fS$$

where

H = flight height above mean ground elevation;
f = camera focal length;
S = denominator of the representative fraction expressing the required mean negative scale.

The departure from the computed flight height above mean ground elevation shall not exceed 2 per cent lower or 5 per cent higher for all flights up to 4,000 above mean ground elevation. For all flight heights above 4,000 above mean ground elevation, the departure from the computed flight height shall not exceed 2 per cent lower or 200 higher.

E. Time of photography

Photography shall be undertaken only when the lighting and weather conditions are such that acceptable negatives can be produced. Any special requirements regarding the season, foliage, snow cover, floods or other limiting conditions will be specified in the schedule of specific requirements for the project. Photography shall not be attempted when the ground is obscured by haze, smoke or dust, or when clouds or cloud shadows appear on any photograph.

F. Solar altitude

The solar altitude shall be at least 30 degrees. For photography in some applications it is necessary that an upper limit be placed on the solar altitude such that the point of direct reflection of the sun will fall outside the photographs. This requirement will be specified in the schedule of specific requirements for each project.

G. Crab

During photography the camera shall be compensated for the crab of the aircraft such that the edges of the photograph in the line of flight are parallel to the flight path within 5 degrees.

H. Tilt

Departure of the camera lens axis from the vertical (tilt) of any exposure shall not exceed 4 degrees and the average for any project shall not exceed 1 degree. Relative tilt between any two successive photographs shall not exceed 6 degrees.

I. Course corrections

Corrections to the aircraft's course between successive photographs shall not exceed 3 degrees.

J. Aircraft

The aircraft shall be of a type suitable for performing the photography specified. It shall have a service ceiling with operating load (crew, camera, extra film, oxygen, equipment, parachutes, etc.) of not less than the highest altitude required for the project. It shall conform to all official regulations and ordinances appertaining in the project area. The design of the aircraft shall be such that when the camera is in position, with all of its parts above the outer structure of the aircraft, an unobstructed field of view for the total image area of the camera when oriented at the maximum allowable tilt shall exist. The field of view shall, so far as is practicable, be shielded from exhaust gases, oil and turbulence of airflow caused by the propellers.

1. Camera port glass

The surfaces of the camera port glass shall be plane-parallel to within 10 seconds of arc. It shall have spectral transmission characteristics which are compatible with the spectral sensitivity characteristics of the camera lens-film combination of the project. The thickness of the port glass and its mounting in the aircraft shall be such that these requirements shall continue to be met after installation and when operating in the environment necessary to perform the aerial photography. The camera port glass shall be kept clean and free of scratches.

2. Altimetry

The aircraft shall be equipped with a calibrated altimeter and with calibrated inside and outside temperature gauges for determination of applicable indicated flight altitude for the project.

The altimeter shall be set and maintained at the closest applicable altimeter setting to the project area. A record of the outside air temperature and the altimeter setting will be maintained for each flight line or more frequently if changes greater than 2° C or 0.3 mm of mercury, respectively, are encountered on one flight line. The ground station or source of the altimeter setting will be indicated.

3. Temperature control

The camera compartment shall be maintained at a temperature of 15° C ±10° C. Temperature variations shall not exceed 4° C from place to place in the camera, magazine or film.

4. Humidity control

Humidity should be controlled in the camera compartment to 58 per cent ±2 per cent relative humidity. The film should be kept at that humidity from the time it is removed from its sealed container until it is exposed. If no humidity control is used, the camera shall be started sufficiently long before the beginning of each flight line to take at least the number of exposures indicated in the table below before beginning the line. These exposures should all be taken at the usual time interval, and at least the last four shall be taken at the usual time interval.

Time since end of preceding line or loading of magazine	Number of extra exposures before line
Less than 30 minutes	4
30 minutes to 2 hours	7
2 hours to 8 hours	10
8 hours to 24 hours	13
24 hours to 4 days	16
4 days or longer	19

5. Camera mounting

The camera shall be insulated from the vibrations of the aircraft by a suitable mount which also has provision for levelling the camera in flight and compensating for crab of the aircraft. The camera mount shall provide sufficient vibration insulation so that the camera vibration need never be a limiting factor in the selection of shutter speeds. The maximum angular velocity of the camera due vibration shall be less than

$$A = \frac{D}{FT}$$

where

A = angular velocity in radians per second;
D = average resolved distance in millimetres for the lens-film combination;
F = camera focal length in millimetres; and
T = total exposure time in seconds (maximum for the project).

K. Operations report

An operations report shall be submitted to the contracting authority with each roll of processed film. This report shall include the following information: film roll number; aircraft number; name of pilot; name of photographer; camera type; camera number; lens number; filter type and number; magazine number; film type; emulsion number and film expiration date; aperture setting; shutter speed; flight line designations or numbers; direction of flight for each line; date of exposure for each line; line location (from-to); local standard time of start and finish of each line; number of exposures in each line; planned flight altitude for each line; indicated flight altitude for each line; altimeter setting and outside air temperature for each flight line; date film processed; developer used; temperature of developer; development time; step wedge information; and any pertinent comments, including meteorological conditions.

II. CAMERAS

A. Construction

Cameras shall be calibrated precision type, with a rigid mechanical structure which holds the lens, fiducial marks and the parts that define the focal plane. The mechanical structure holding these components shall be supported in use in such a manner that strains cannot be transmitted to it from the supporting body or mount.

B. Focal length and format

The camera focal length and format shall be one of the following, as specified in the schedule of specific requirements for the project.

	Category	Calibrated focal length (mm)	Normal format (cm)
A	(Standard wide angle)	153 ±3	23 x 23
B	(Super wide angle)	88 ±3 or 85 ±3	23 x 23
C	(Normal angle)	210 ±3	23 x 23
D	(Narrow angle)	305 ±5	23 x 23

C. Focal plane

The film shall be held in the focal plane by a register glass with a pressure pad or by a vacuum back. The platen against which the film is pressed at the instant of exposure shall not depart from a true plane by more than ±0.013 mm. For vacuum-back cameras, the vacuum differential at the magazine shall not be less than 25 mm of mercury.

D. Fiducial marks

Fiducial marks shall be provided such as to produce accurate and definite registrations on every negative and such that they are not easily disturbed by accidents or other causes. They shall provide for recording two fixed mutually perpendicular camera distances on each negative. Lines joining two opposite fiducial marks shall intersect at 90 degrees within ±1 minute of arc. The principal point of autocollimation, the point of symmetry and the indicated principal point shall be within a 30-mm diameter circle. It is essential that fiducial marks on photographs procured for analytical aerotriangulation be of a design that will facilitate precise location of the centre of the mark in a stereo comparator. Fiducial marks situated in the corners of the format shall not project more than 2 cm, measured from the corner, into the 23 cm x 23 cm area. Fiducial marks on the sides of the format shall not project more than 1 cm into the 23 cm x 23 cm area.

E. Shutter

The camera shutter shall be of the between-the-lens variable speed type, so that light is transmitted simultaneously to all parts of the format when the shutter is open. The efficiency of the shutter shall be at least 70 per cent at the maximum aperture.

F. Filter

Filters shall be used as necessary to provide proper control of the spectral characteristics of the light involved in the imaging process and also to control the relative illumination from the centre to the corner of the focal plane format. The spectral transmission of the filter shall conform to the recommendations of the manufacturer of the particular film employed, due consideration being given to the lighting conditions and atmospheric attenuation anticipated for the project as well as the spectral transmission of the camera optics. For relative illumination control the filter shall have a neutral metallic graded density coating on the surface towards the camera lens. The filter shall be mounted in front of the lens and shall be considered a part of the optical system of the camera. A camera shall be calibrated with the primary filter with which it is to be used.

1. Filter optical quality

Filters shall be of optical glass, free of bubbles, striae and scratches. The surfaces of any filter shall be plane-parallel to within 10 seconds of arc. The optical quality of the filter shall be such that its addition and use shall not cause any undesirable reduction in image resolution, and shall not harmfully alter the optical characteristics of the camera lens.

2. Filter orientation

Provision shall be made to ensure that a single orientation of the filter on the camera can be easily and reliably maintained and measured. The single orientation may be established either by mechanical arrangements of by clear markings or by a combinatin of the two methods. Orientations shall be established for the filter in its cell as well as for the cell on the camera.

G. Focal plane illumination

For panchromatic and infra-red photography, the lowest film plane illumination shall not be less than 30 per cent of the highest film plane illumination. For colour infra-red and colour photography, the lowest film plane illumination shall not be less than 50 per cent of the highest film plane illumination. The illumination at the centre of the film plane shall not be less than 90 per cent of the highest illumination found.

H. Distortion

1. Radial distortion

The average of the radial distortion measured on four diagonals from lens axis to edge of field in the focal plane and based on the calibrated focal length shall not exceed $\pm$0.010 mm for category A, C and D cameras, and $\pm$0.020 mm for category B cameras. The asymmetry of radial distortion measured on four diagonals from lens axis to edge of field shall be such that the largest absolute difference between measured radial distortion and the average radial distortion shall not exceed 0.005 mm.

2. Decentering distortion

For all camera categories the maximum decentering distortion measured in the focal plane shall not exceed 0.010 mm.

I. Resolution

For category A cameras, the resolving power of the lens shall be such that the resolution on a Kodak spectroscopic plate, type V-F, that has been exposed in the focal plane, is a minimum of 34 line pairs per millimetre from the centre to a

field angle of 40 degrees. The area-weighted average resolution (AWAR) shall be a minimum of 56 line pairs per millimetre.

Note: Further studies are required to complete the specifications f or "2.9 resolution", including resolution on film and resolution for cameras of categories B, C and D. These additional specifications will be submitted in the near future.

J. Lens aberrations

The lens used shall be free from excessive or objectionable aberrations. The type of camera and lens combination that will be used shall be indicated by the contractor before a contract is awarded.

1. Colour correction

The lens shall be colour corrected over the spectrum of wavelengths applicable to the film-filter combination employed.

2. Anti-reflection coatings

All lens surfaces shall have anti-reflection coatings.

K. Calibration and test reports

Each camera shall be calibrated and tested by a competent testing organization or organizations, and certified reports of calibration and test shall be submitted to the contracting authority to assist the contracting authority in the determination of conformance to applicable portions of the present specifications and general suitability for the project prior to award of contract. The reports shall be based on tests and measurements made after final assembly of all parts of the camera including the filter. All calibration and test exposures shall be made at maximum aperture. The reports shall supply the following information (suggested forms for these reports are shown in the annex):

(a) Calibration report

(i) The calibrated focal length of the lens as mounted in the camera, with a standard error not exceeding 0.005 mm;

(ii) The radial distortion, referred to the calibrated focal length, along each plate diagonal from the lens axis to the edge of the field, by 5° or 7-1/2° intervals, with a standard error not exceeding 0.005 mm;

(iii) The average radial distortion, referred to the calibrated focal length, from the lens axis to the edge of the field, by 5° or 7-1/2° intervals;

(iv) The maximum decentering distortion in the image plane;

(v) The distances between fiducial marks with a standard error not exceeding 0.010 mm;

(vi) The location of the principal point of autocollimation and of the point of symmetry with respect to the indicated principal point, with a standard error not exceeding 0.005 mm; and

(vii) The angle between the lines joining opposite fiducial marks, with a standard error not exceeding 10 seconds of arc;

(b) Test report

(i) The radial and tangential resolving power of the lens as mounted in the camera, along each plate diagonal from the lens axis to the edge of the field, by 5° or 7-1/2° intervals;

(ii) The efficiency and effective exposure time of the shutter mounted in the camera, when exposure time is set at marked values for the maximum, minimum and median shutter speeds;

(iii) The film plane illumination along both diagonals of the format; and

(iv) The focal plane platen flatness.

It shall be certified that the camera lens cone and lens have not been disassembled since calibration. The date of calibration shall not be more than three years prior to date of submission.

L. Flash plate

If required by schedule of specific requirements, a glass plate negative flash exposed in the focal plane of the camera and showing clearly all fiducial marks shall be furnished to the contracting authority along with the calibration and test report. The negative shall be marked with the date of test, the camera and lens numbers and the number or other appropriate identification of each fiducial mark corresponding to the designation used in the calibration and test report.

M. Film spools

Film spools shall have a core diameter of at least 50 mm and a flange diameter equal or larger than the diameter of the film roll.

N. Auxiliary recorded data

The auxiliary data to be photographically recorded shall be specified for each project in the schedule of specific requirements. The data recordings shall be easily read. Care should be taken to ensure that instrument lights are operating

during photography and the exposure is adjusted to give good legibility on prints. Where a camera altimeter is recorded, the recording shall be in good agreement with the calibrated aircraft altimeter values. Time recording, where provided, shall be local standard time.

O. Operational tests

Upon request of the contracting authority, the contractor shall make a service test over a designated area with each camera system and auxiliary equipment that he proposes to use in the performance of the project, and shall submit the results to the contracting authority. The operational test photography shall consist of a series of six or more overlapping film negatives made with the camera or camera systems proposed for use. The negatives shall be made from approximately the same altitude and of similar terrain designated in the schedule of specific requirements for performance of the project, and shall conform to all other applicable requirements of these specifications. The film exposed on the operational test shall be identified as to exposure number, contractor's name, altitude of photography above mean ground level, types and serial numbers of lens, camera number, magazine number, type and number of aircraft, filter type and number, shutter speed, f-stop, date and hour of exposure, and name of photographer and pilot. The sample negatives will be used by the contracting authority to assist in evaluation of contractor capability to conform to specification requirements. Glass diapositives, prepared from the sample original film will be used to produce stereoscopic models for the purpose of testing the quality and flatness of the stereoscopic model.

III. AERIAL FILM

Only dimensionally stable polyester base unexpired film shall be used. The film base, excluding the emulsion, shall not be less than 0.10 mm in thickness and 24.1 cm in width. The particular classification of aerial film to be used shall be specified in the schedule of specific requirements in one or more of the following categories.

A. Panchromatic film

This is a black and white film category with spectral sensitivity in the range of approximately 400 to 750 nanometres.

B. Infra-red (black and white) film

This is a black and white film category with spectral sensitivity range extended beyond that of the panchromatic film category and into the near infra-red spectral region.

C. Reversal colour film

This is a three-layer colour film emulsion category, with blue-, green- and red-sensitive layers, which, when processed, produces a colour positive transparency.

D. Negative colour film

This is a three-layer colour film emulsion category with blue-, green- and red-sensitive layers, which, when processed, produces a colour negative.

E. Colour infra-red film (false colour)

This is a colour film category differing from the usual colour emulsion in that the three emulsion layers are sensitive to green, red and infra-red radiation.

IV. FILM SELECTION

The type of film within the category shall be selected with deliberate regard to the image characteristics required by end use of the photography and these specifications, the brightness range of the terrain to be photographed, the atmospheric conditions anticipated at the project site, the characteristics of the illumination at the time of photography and the camera and aircraft performance characteristics. Unless specifically indicated otherwise in the schedule of specific requirements, the contractor shall select the type of film to be used and shall state in his proposal the type of film to be employed, including the name of the manufacturer, the emulsion and the supporting base material. The operational test samples (see sect. II.0) shall be made using the type selected.

V. EXPOSURE

The exposure shall produce a negative (or a positive transparency) that results in most of the image densities being on the approximately straight portion of the characteristic curve of the photographic material. The minimum density should be no less than 0.3 above base fog. In choosing the exposure to meet these requirements, consideration must be given to the effective film speed at the gamma necessary to deal with the brightness range of the terrain to be photographed. The exposure shall be made at the aperture and shutter-speed setting for maximum resolution. When image motion due to ground speed is likely to be the limiting factor on resolution, exposures shall be made at maximum shutter speed consistent with adequate exposures.

VI. PROCESSING

Processing procedures shall be in accordance with the recommendations of the manufacturer of the film type used. For black and white negatives the degree of development shall be determined with due regard for the brightness range of the terrain photographed. The gamma should be no less than 0.6 and usually no more than 1.2, although in extreme cases where the photography is of terrain of low brightness range, processing to a gamma value as high as 1.5 may be desirable. The lower values of gamma apply to areas with high brightness range, such as in mountainous areas where deep shadows and sunlit snow may occur in close proximity.

The processing procedures shall be sufficiently uniform to ensure that for any single sensitometric exposure, the gamma shall not vary more than 10 per cent from the intended value, or from the mean value for the project if no intended value was established. A sensitometric step-wedge shall be printed at least once on each roll of film processed. With rewind film processing, printing at the end of the roll should be avoided if possible. Complete information on characteristics of the step-wedge, the spectral distribution of the illuminant and the exposure time shall be furnished to the contracting authority with the roll of processed film.

The processing procedure shall not have an injurious effect on the dimensional characteristics of the photographic image. At no time during development or drying shall the film be subjected to a tension or a temperature sufficient to cause permanent dimensional changes. To obtain good maintenance of film dimensions, it is generally desirable to keep the tension below 180 grams per centimetre of width, and the drying temperature below 38° C.

VII. QUALITY

The photography shall be clear and sharp in detail, of uniform density range, and shall have the proper degree of contrast for all details to show clearly in both shadow and highlight areas. Photography having excessive contrast, or low in contrast, may be rejected. It shall be free from clouds and cloud shadows, smoke, haze, light streaks, development streaks, excessive snow, static marks, shadows, tears, scratches, water marks, and other blemishes that would interfere with its intended purpose. Proper allowance will be made for the presence of water bodies, deep shadows or snow fields, if, in the opinion of the contracting authority, the contractor has excercised reasonable care to ensure that the negatives meet the requirements of density and contrast.

VIII. FILM SPLICES

All splices shall be of a permanent nature accomplished with pressure sensitive polyester base tape. The splices shall be of the butt-joint type with tape placed on both sides of the splice. Particular care shall be given to the alignment of the film when splicing, with care taken to trim all excess binding tape in order that the film be perfectly straight after splicing. No trimming or splicing of film shall be made at a distance of less than 50 cm from any acceptable exposure.

/...

IX. CONTACTS PRINTS

One print each of the photographs submitted for acceptance shall be furnished with the processed aerial film. The prints shall be on double-weight semi-mat paper and shall be such that the dry prints remain flat indefinitely over a wide range of relative humidities. All prints shall include a legible image of all auxiliary instrument recordings. Special care shall be exercised to ensure proper development and thorough fixation of prints. Prints shall be clean and free from stains, blemishes, uneven spots, air bells, light fog, development streaks and finger marks, and shall be thoroughly washed to clear them of chemicals that would impair their permanency. Prints shall be uniform in tone and density, and the degree of contrast shall be such that all details in both shadows and highlights will show clearly.

X. ANNOTATION

Each photo shall be clearly annotated on the film in accordance with these specifications before printing. The annotation shall be made with permanent-type ink that will not chip off when dry. The annotation shall include a one to four-letter symbol that identifies the project, followed by a number designating the number of the film roll within the project, and the number of the photograph within that roll, thus, ABCD-11-121, in which ABCD is the project designation, 11 is the number of the film roll, and 121 is the number of the photograph in that roll. Film rolls shall be numbered consecutively for a project, beginning with the number 1, and photographs shall be numbered consecutively for a film roll, beginning with the number 1. A roll shall contain photography from one camera only. All letters and numbers shall be inside the image area and shall be not more than 5 mm high, and within 1 mm of the edge of the photograph. For north-south flights, the annotation shall be in the north-east corner and along the east-west edge of the photograph. The position of the annotation in the east-west direction shall be selected to ensure legible reproduction. For east-west flights, the annotation shall be in the north-west corner and along the north-south edge of the photograph. The position of the annotation in the north-south direction shall be selected to ensure legible reproduction. Examples of the arrangement and location of the annotation on each photograph are shown in figure I.

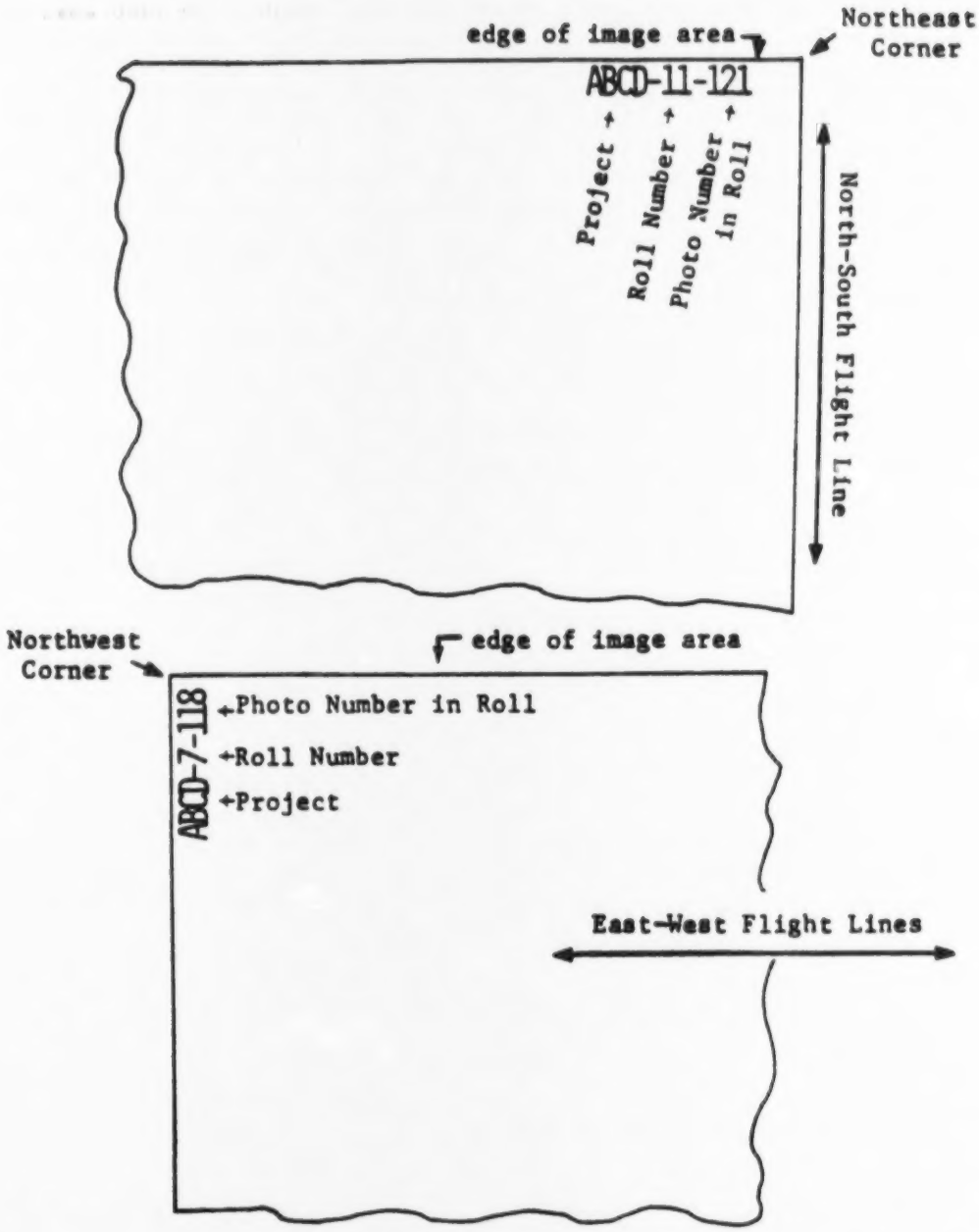


Figure I. Example of arrangement and location of the annotation on each photograph

Additionally, the first and last photograph of each flight line or segment of a flight line shall be annotated with the date, local standard time of exposure, lens number, altitude above mean sea level in metres thus, 20 Oct. 90 1300 AB45 5,000 m, in which 20 Oct. 90 is the photography date, 1300 is the local time, AB45 is the lens number, 5,000 is the altitude above sea level, and m designates metres. An example of the arrangement and location of the annotation on the first and last photograph is shown in figure II.A.

Each roll of film shall be annotated on each end in an area outside of but close to the first and the last exposure in the roll with the following information:

Project designation	Flight altitude
Contract number	Roll number
Camera type	Line numbers in the roll
Camera number	Negative numbers in the roll
Lens number	Film type
Calibrated focal length	Filter type
Date of photography	

An example of the annotation of each end of each roll is shown in figure II.B.

A. First and last photo of each flight

Project—ABCD	Contract—476
Camera—AB4567	Camera type—RC8
Lens—6847 (Aviogon)	Calibrated focal length—151.87 mm
Date of photography—20 Oct 68	Altitude—5,000 m
Roll—8	Filter—Kodak Wratten No. 12
Negative numbers—8-1 to 8-125	Film—Kodak Infra-red Aerographic, Type 1A, Class K (topographic)
Line numbers—1, 2, 3	

B. Each end of each roll

Figure II. Example of annotation on first and last photograph of each flight line and at each end of each roll

XI. INDEXES

A. Photo-index

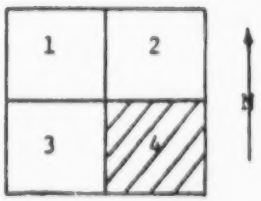
When specified in the schedule of specific requirements, the photo-index shall be prepared by photographing, at approximately one-fifth scale, a stapled assembly of glossy contact prints, trimmed to the edge of the image area, except for that edge on which titling data appears. Wherever the index cannot be copied photographically on one negative, it shall be copied sequentially on two or more negatives as necessary. The prints shall be laid to match images approximately, with successive prints and strips overlapping like shingles. On the exposed corner of each print there shall be a stick-up white rectangle bearing in black the number of the print, of such size as to be read easily on the photo-index. Similar stick-ups shall be placed showing the number of each strip. All photo-indexes of each project shall be at a uniform scale to facilitate matching of adjoining indexes.

The photo-index shall have a neatly executed title showing the project designation, contractor's name and contract number, date of photography, type of camera, focal length, lens number, magazine number and platen identification number where available, approximate scale of photography, approximate scale of photo-index, photo-index sheet number and index to the sheets of the photo-index, a north arrow and arrows indicating the heading of each flight line. Suggested arrangement of the information in the title is shown in figure III.

The geographic or grid co-ordinates of the corners of the photographic index will be shown by tick marks (in the form of a short cross mark) and the co-ordinate values of the corners shall be shown in an appropriate position in relation to the tick marks.

PROJECT DESIGNATION

Location Diagram



Contractor_____

Contract Number_____

Camera Type_____Focal Length_____

Date of Photography_____Scale_____

Index Scale_____

Sheet Number_____

Figure III. Suggested arrangement of information in photoindex title

B. Index map

When specified in the schedule of specific requirements, the index map shall be prepared as an overlay to an existing map of the area. It shall contain lines showing the location of each flight and the outline of the coverage of at least every fifth photograph and the end photographs of each flight. Photograph numbers shall be shown for all photographs outlined. Requirements for titling, sheet indexing and geographic or grid co-ordinate, designation shall be the same as specified for the photo-index.

XII. INSPECTION OF MATERIALS

Whenever it is feasible, inspection of photography shall be made at the plant of the contractor, and the contractor shall provide all the facilities necessary for the inspection. The contracting authority shall be given access to plant, equipment and facilities of the contractor during performance of the contract as necessary to determine compliance with the provisions of this specification.

Materials submitted to the contracting authority for inspection and acceptance of film quality and photographic coverage shall include all processed original film numbered and indexed, one set of contact prints of the photography, and detailed operations reports for each roll of film.

The contracting authority will make every effort to inspect all material specified in the contract within 30 calendar days after they are received at the designated final destination. Should the inspection procedure be delayed longer than 30 days, the contractor will be notified of the reason(s) for delay and provided the projected completion date.

XIII. TIME ALLOWANCES

The maximum time allowance for notification that materials are ready for inspection shall not exceed 21 calendar days from the time photography is completed. In the event that inspection of materials indicates the necessity for reflights for the project, the contractor shall undertake such reflights within three days after receipt of notice to proceed. When a delay occurs in undertaking the reflight due to work required in photographing reflights previously ordered or because of poor photographic weather, an extension will be allowed equal to the delay caused by those circumstances. The maximum time allowance for notification that rephotography is ready for inspection shall be five calendar days from the time re-photography is completed.

XIV. DELIVERY OF MATERIALS

Unless otherwise specified in the schedule of specific requirements, the materials to be delivered to the final destination designated by the contracting authority are:

(a) All accepted and rejected aerial film;

(b) One contact print of each photograph on double-weight semi-mat paper;

(c) One copy of each photo-index sheet;

(d) All photo-index negatives;

(e) Operations reports;

(f) Camera calibration and test reports;

The maximum time allowance for shipment of the aerial film, prints, operations reports and camera calibration and test reports shall be 10 days from official notice of acceptance of the photography. The maximum time allowance for the shipment of photo-index negatives an prints shall be 20 days from the official notice of acceptance of photography.

Final acceptance of a project will be made after inspection of all delivered materials at the designated final destination. The materials to be furnished as part of this contract shall be delivered FOB Destination within consignee's premises.

XV. SCHEDULE OF SPECIFIC REQUIREMENTS

A schedule of specific requirements will be issued by the contracting authority for each project and will include the following as applicable:

(a) Statement of general requirements and purpose of the photography;

(b) Detailed operational requirements including:

(i) Area to be photographed (sect. I.A);

(ii) Flight line plan (sect. I.B);

(iii) Flight height, photo scale (sect. I.D);

(iv) Endlap and sidelap (sect. I.C);

(v) Time of photography (sect. I.E);

(vi) Solar altitude limitations (sect. I.F);

(c) Photographic requirements including:

(i) Camera category and focal length (sect. II.B);

(ii) Fiducial marks (sect. II.D);

(iii) Filter (sect. II.F);

(iv) Operational test requirement (sect. II.O);

(v) Film (sects. III and IV);

(vi) Gamma (sect. VI);

(vii) Requirements for auxiliary recorded data (sect. II.N);

(viii) Index requirements (sect. XI);

(d) Inspection, delivery and acceptance requirements, including:

(i) Place of inspection (sect. XII);

(ii) Place of destination and final acceptance (sect. XIV);

(iii) Delivery instructions;

(e) Requirement for flash plate negative (sect. 2.12);

(f) Allowable deviations from specification requirements.

XVI. CONDITIONS OF BIDDING

A. Bid data

Each bid shall be accompanied by the following:

(a) Calibration and test reports for each camera proposed to be used on the project;

(b) Make and model of aircraft to be used, together with a certified copy of the applicable aircraft registration, airworthiness and engine records;

(c) Bid guarantee;

(d) Plan for contract performance;

(e) Type and make of film to be used;

(f) Evidence of qualifications and experience of each crew;

(g) Contractor's analysis of his capability of completing the project in one season, including considerations of size of project area, normal weather in the project area and equipment and personnel to be assigned to the project;

(h) Operational test photography, if requested in the schedule of specific requirements.

B. Bidder qualifications

The right is reserved to reject any bid where investigation of the business and technical organization of the bidder, including financial resources, equipment and experience on similar projects, does not satisfy the contracting authority that the bidder is qualified to perform the work.

C. Bidder responsibility

Bidder is expected to examine the specifications, to visit the locality of the work if necessary, and to make his own estimate of the facilities needed and the difficulties attending the execution of the project, including local conditions, uncertainty of weather, availability of landing fields, restricted or classified areas, adjacent countries airspace, and all other contingencies. No additional costs will be allowed for errors, omissions or misunderstanding on the part of the bidder. Any request for clarification or interpretation of any portion of the specifications shall be submitted in writing or by telegram to the contracting authority issuing the invitation to bid at least one week prior to the time fixed for opening the bids, in order that he may notify all prospective bidders of such interpretation or clarification, without the necessity of postponing said time of opening. Any and all exceptions to the provisions of this specification shall be clearly defined in each bid.

The maximum time allowance for notification that reflight photography is ready for inspection shall not exceed 14 calendar days from the time the reflight photography is completed.

D. Bid guarantee

Each bid in excess of $2,000 (or equivalent in specified currency) shall be accompanied by a bid guarantee of not less than 10 per cent of the amount of the bid, which guarantee may be a certified cheque made payable to the contracting authority. Each such guarantee shall be submitted with the understanding that it shall guarantee that the bidder will not withdraw his bid within the period specified for opening of the bids; that he will, if his bid is accepted, give performance bond as may be required; and that, in the event of the withdrawal of his bid within said period, or the failure to give performance bond within the period specified, the bidder shall be liable to the contracting authority for the difference between the amount specified in his bid and the amount for which the contracting authority may otherwise procure the required work, if the latter amount

be in excess of the former, and the contracting authority shall have the right to retain the proceeds of such bid guarantee to apply on account of such excess cost. Bid bonds of unsuccessful bidders will be returned when award is made. Bid bond of successful bidder will be returned when the performance bond is approved.

E. Bid evaluation

In determining the successful bidder, the contracting authority will consider, in addition to the bid price, factors such as: availability, characteristics, adaptability of equipment and personnel, financial responsibility, skill, experience, record of integrity in business, ability to furnish repairs and maintenance services, past record of performance, and the amount of unfinished projects that each bidder has under contract and the location and season for photography of these projects. Any other factor not specifically mentioned or provided for herein, in addition to that of the bid price, that will affect the final cost to the contracting authority will be taken into consideration in making award of the contract.

XVII. PERFORMANCE BOND

If the total amount of the resulting contract is $2,000 (or equivalent in specified currency) or more, the bidder to whom the award is made shall furnish, within 10 days after receipt of notice of award, a performance bond for the faithful performance of the contract. Such performance bond shall be in a sum not less than the total contract price.

XVIII. AWARD AND NOTICE TO PROCEED

The notice of award will be given by mail or by telegram. The notice of award will constitute notice to proceed unless otherwise specified on the notice of award. Notice to proceed, if given at a later date, will be given by mail or telegram.

XIX. COMMENCEMENT AND PROSECUTION OF WORK

Upon receipt of award, if he has not already done so, the contractor shall notify the contracting authority in writing as to where he proposes to base his flying operations and where he proposes to perform the work other than the flying, and shall keep the contracting authority advised of any changes in these bases of operation. The contractor shall initiate the photography of the areas to be photographed within 10 days after receipt of the notice to proceed, or within such time as may be specified in the schedule of specific requirements or notice to proceed. The time for starting the work may be postponed if, in the opinion of the contracting authority, snow, high water, leaves or other cause renders photography of the area impracticable. The contractor shall notify the contracting authority by registered mail or telegram the day his flying equipment and personnel arrive on

the project, and they shall remain continuously on the project and shall prosecute the work expeditiously until the photography specified under the terms of the contract is completed and the contracting authority notifies the contractor that all of the photography is approved. In the event that the flying season expires before the photography is completed, work on the project shall be resumed during the next flying season. The contractor may remove the plane and camera crews from the project prior to completion of the work only when authorized by the contracting authority. The contractor shall return the aircraft and camera to the project within 10 days after receipt of notice to resume work.

XX. RISKS AND DAMAGES

The contractor shall assume all risks in connection with the performance of the contract, and shall be liable for and save the contracting authority harmless from and against all claims, demands, losses, damages, action, suits or other proceedings, of whatever nature, arising out of or in connection with carrying out of his contract.

XXI. SUBCONTRACTS

The contractor shall not, without prior written approval of the contracting officer, enter into any subcontract covering any part of the work contemplated by his contract. If approval is given for a subcontract, the contractor shall furnish a copy of the subcontract agreement to the contracting officer.

XXII. PERMITS AND CLEARANCES

The contractor shall, without additional cost to the contracting authority, obtain all licenses, permits and clearances necessary for the performance of the contract.

XXIII. CODES, ORDINANCES AND REGULATIONS

The contractor shall observe and comply with all laws, by-laws, safety laws, and any and all codes, ordinances and regulations affecting the contract work in any manner.

XXIV. PROGRESS PAYMENT

A progress payment shall be made on invoices for contracts over $2,000 (or equivalent in specified currency) within 30 days of delivery of all materials invoiced. The progress payment shall be in the amount of 75 per cent of the invoice amount less any reduction for unacceptable photography that may prove applicable on inspection. Payment of the balance of invoices on which a progress payment has been made will be deferred until complete acceptability of the

photography has been established and the contract is complete. Progress payments do not constitue evidences of acceptability of the photography, and any such payment for any photography subsequently judged unacceptable shall be debited against the value of portions that are acceptable. In the event that progress payments to the contractor exceed the value of accepted photography, the contractor shall be liable to the contracting authority for the amount of such excess.

Annex

SUGGESTED FORMS FOR CALIBRATION AND TEST REPORTS

NAME OF CALIBRATION LABORATORY

Calibration report

Date:

Camera:

Type —

Serial number —

Format —

Calibrated focal length —

Lens:

Type —

Serial Number —

Equivalent focal length —

Maximum aperture —

Filter:

Type —

Serial number —

Radial distortion in millimetres

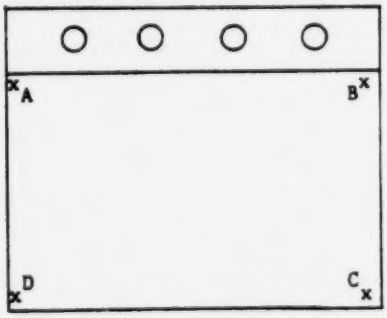
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
Diagonal 1										
Diagonal 2										
Diagonal 3										
Diagonal 4										
Average										

Maximum tangential distortion is.....mm.

The displacement of the principal point of autocollimation or point of symmetry from the intersection of lines joining opposite fiducial marks is within.....mm.

Fiducial Marks

As seen on camera from top



A - B =
B - C =
C - D =
D - A =
A - C =
B - D =

The angle between lines joining opposite fiducial marks is _____.

Figure IV. Fiducial marks

NAME OF TESTING LABORATORY

Test report

Date:

Camera:

Type —

Serial number —

Format —

Lens:

Type —

Serial number —

Equivalent focal length —

Maximum aperture —

Resolving power (lines per millimetre, high contrast)

Aperture —

Film type —

	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
Radial										
Tangential										

Shutter performance

	Shutter setting	*Total open time*	*Effective exposure time*	*Efficiency*
Maximum				
Median				
Minimum				

Focal plane illumination

	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
Diagonal 1										
Diagonal 2										
Diagonal 3										
Diagonal 4										

Maximum departure of the focal plane from a true plane is.....mm.